MEETING SUMMARY
STEERING COMMITTEE
ETV SMALL SYSTEMS PILOT
MAY 19 & 20, 1997

May 19, 1997:
Jerry Biberstine, Steering Committee Chairman, welcomed meeting attendees and read NSF's Antitrust Statement. Meeting attendees (listed at the end of this summary) introduced themselves.

Jerry also summarized the basic objective of the pilot project, which is the verification of new and existing water treatment technologies.

I. Responsibilities of the Verification Entity for the Project (by Jerry Biberstine, Steering Committee Chairman)

A. Relationships Between Participants and the Verification Entity

Bruce Bartley presented a flowchart (Attachment A) showing relationships between the different participants in this ETV pilot project. Jerry mentioned that, in addition to the relationships shown, there is also a relationship between the state and the community in which the verification testing will be performed.

Bruce also displayed a chart outlining the responsibilities of NSF as the verification entity, which included:

- Final Report and Verification Statement Issuance
- Outreach: Communication and Selling of Project Benefits
- Project management and Liaison
- Qualifying Field Testing Organizations
- Coordination of Project Meetings
- Coordination of Peer Reviews of Existing Data
- Coordination of Protocol and Test Plan Development
- Inspection of On-Site Studies

Joe Harrison inquired if NSF must issue the verification statements or if the qualified Field Testing Organizations (FTOs) could issue the reports. Jeff Adams responded that as part of the responsibility of the verification entity, NSF must issue the verification statements. Dissemination of these statements has not been completely determined yet, but each party that puts their name on the report puts their credibility on the line. Therefore, issuance of the statements will be strict. NSF is responsible for qualification of the FTOs and for overseeing them.

B. Recommendations for Qualifying FTOs

Donna Cirolia stated that she likes the idea of having "required" and "secondary" qualifications (see Attachment B), but is concerned about the quality system qualification (a secondary qualification). She asked if testing organizations actually have registered quality systems at this time. Donna also asked if there will be some sort of ranking or weighted scale system for

qualification. Gretchen Rupp added that most universities do not likely have quality systems and therefore probably will not apply as a testing organization.

Jeff explained that this secondary qualification is in line with the EPA's QA/QC vision for the future. He said that they want to recognize this approach for the 21st century, but do not expect all FTOs to have such a system in place at this time.

Steve Clark asked if an organization which has the secondary qualifications will receive a higher creditation and less oversight from NSF. Bruce responded that the more capabilities an organization has to produce a quality document, the less oversight will likely be given them by NSF. Bruce stated that NSF does not anticipate that many of the testing organizations will have a certified quality system.

C. Draft Process and Procedures for Qualifying Testing Organizations

Bruce Bartley discussed a chart (Attachment C) showing the process for qualifying testing organizations. Bruce explained that for microbiological and chemical testing laboratories, going through this process will not make them "NSF Certified," but acceptable to use for analysis of samples for this project.

David Pearson asked about international labs and their potential for 3rd party certification to an ISO standard. Bruce DeMaine stated that there are 3rd party certifiers internationally which could accredit labs to ISO Standards.

D. Draft Terms and Conditions for FTOs

Bruce Bartley reviewed key points from the draft "Terms and Conditions for Qualifying FTOs." The FTO, on behalf of the manufacturer, will apply for verification testing, oversee the testing, and prepare the verification report and verification statement. Bruce also stated that fees have yet to be determined by NSF and the EPA. NSF will publish an announcement in the Commerce Business Daily and send the announcement to testing organizations on NSF's mailing list, when NSF begins qualification of testing organizations.

Bruce clarified in response to a question from Jim Bell that there will not be any contractual agreement between NSF and the analytical laboratories because they are already certified for drinking water analyses by one or more states. On the other hand, states do not qualify FTOs, and that is why NSF will qualify them to perform on-site verification testing.

Donna Cirolia stated that Steering Committee members should not be required to vote on any policies until they have a good idea what the fees are going to be to the testing organizations and the manufacturers.

Jeff Adams asked if there were any concerns from the FTOs at this time. Gretchen Rupp responded that she is not sure if universities will be able to participate because many universities (especially those receiving government funds), it is against their policy to participate in a

competitive market.

Joe Jacangelo asked whether the data submitted by the manufacturers will be held confidential. Bruce responded that the manufacturers and FTOs will have to create a contract between themselves regarding confidentiality. As far as the EPA, they are subject to the Freedom of Information Act, so any proprietary information that the manufacturers do not want disclosed should not be submitted with the verification testing information.

Jim Bell asked about complaints against the FTOs: who will review and investigate these complaints? Bruce responded that the verification entity (NSF) is responsible for this matter.

John Dyson restated concerns about confidentiality. Will the statements be published to the public? They might contain design-specific information that competitors could read and copy. Jeff Adams stated that the manufacturer will have input into the report that the FTO prepares so they will have some control over what is disclosed. Jerry Biberstine stated that the type of information that is normally considered proprietary is not needed by the states to determine applicability of the technology. Bob Mann added that the states realize that not all design information will be submitted and that the manufacturers should be informed that the information they submit will be in the public domain.

Motion #1: Allen Hammer motioned to finalize the draft "Terms and Conditions" other than the fees portion of the document. Donna Cirolia seconded the motion. The Steering Committee approved unanimously.

E. Communication with Local Participant Communities

Jerry Biberstine brought up the topic of communication with the participating community for discussion. John Dyson suggested that communication can be developed through the operator of the plant where the verification testing will take place.

F. EPA/NSF Verification Report and Statement

Bruce Bartley discussed the final product: Do people want a statement or report with both the EPA and NSF names and logos? Joe Harrison thinks that NSF would be fine to have on the reports and that the EPA should definitely be on the reports. Brenda Land stated that there may be a concern from some manufacturers that they will have to pay a yearly fee if they have a verification report from NSF. Bruce stated that only the FTO will pay an annual fee to NSF for qualification services.

II. State Survey on Pilot Testing Requirements (by Jerry Biberstine, Steering Committee Chairman)

NSF is in the process of following up on the survey with states that did not respond in order to get a more thorough and representative result. Jerry reviewed the results that have been received to date. Jerry stated that ultimately we want state buy-in so the pilot benefits the states and the manufacturers. He thinks the states are probably hesitant to approve the verification based on a

verification statement because they have not seen one yet. Once they see the format and content of these reports, they may be more willing to waive pilot testing.

Donna Cirolia stated that she was discouraged by the results at first, but Jerry's interpretation is hopeful. Manufacturers have to be conscious of the value for them of the verification; will there be payback for their efforts? Typically, the municipal market favors low bidders and therefore manufacturers need to take measures to keep costs down.

Allen Hammer agreed with Donna and sees the need for states to reduce the current requirements. The states realize they cannot go on as they are now.

Jerry stated that a lot will depend on the quality of the verification report. If the quality of the report is broad enough, it will find acceptance with the states. Bob Mann agreed that when the process is better understood, the states will feel more comfortable relinquishing some of their control. The wording of the survey questions did not encourage states to say they would reduce pilot testing.

Joe Jacangelo asked whether the process will allow for updates to verification statements based on changes in the treatment equipment. Jerry responded that the manufacturers will not likely need an updated statement unless the technology is more lax or you change the composition of the equipment.

Jim Bell asked if it would be possible to get a list of the state contact people so manufacturers could contact them directly if needed. Jerry asked Bridget O'Grady if ASDWA could provide such as a list and she responded that it would be possible.

Harry Grenawitzke stated that the survey asked the states if they would reduce pilot testing based on a report that they have not seen. Since the states will drive the pilot reduction, we should try to create the reports to the states' liking. Jerry agreed and added that maybe we could contact the states in which pilot plant criteria have already been established and get ideas from them as to what to include in the report and in what format.

States suggested to be contacted included California, Washington, Ohio, Pennsylvania, New York, North Carolina, Texas, Massachusetts, and possible Ontario and/or British Columbia. Commonalities in the requirement of these states will be used to mold report format and structure. NSF will collect this information and create a draft for the Steering Committee to review.

Donna Cirolia suggested less intense follow up on the current survey with the idea that after a draft report is created, the states will be surveyed again with that format to review and base their answers on. Kim Fox suggested asking the states "What would it take for the verification report to be acceptable to you to reduce pilot testing?"

III. Task Force on Existing (Historical) Data (by Jeffrey Adams, USEPA)

A. Presentation of Results

Jeff reported that all ETVs are grappling with the concept of existing data and that this ETV pilot project seems to be leading the way on this issue. He thinks we should forge ahead with the ideas that we have developed. Several ideas came out of the conference call held among the members of the Task Force on Existing Data:

- There is value from data from previous studies, as long as the data is credible.
- Existing data is especially beneficial to exhibit a panoramic view or range of treatment performance and cost under various water qualities to support verification testing, which may just show a snapshot of the equipment's capabilities.
- Existing data could be used to identify gaps in the matrix of demonstrated equipment capabilities that can be addressed under new verification testing.
- Is existing data equal to verification testing? Rarely will it have adequate QA for verification (methods, parameters, 3rd party oversight, etc.)

Existing data must be evaluated under a different process with different acceptance criteria than verification, yet result in a credible, useful product:

- Allow for different acceptance criteria and QA/QC to be specified for each technology application area (i.e., categorize by protocol and test plan)
- Allow for use of state compliance data as part of the documentation
- A consistent format for presentation of existing equipment performance data should be established to address states' and users' needs.

Existing data can support verification to:

- Identify data gaps
- Provide possible justification of a variance requested by the manufacturer concerning the length and scope of ETV verification testing.

Based on the comprehensiveness of the existing data package, will the manufacturer still need verification testing? If the manufacturer thinks the existing data package is sufficient, it can choose not to proceed with verification testing. But the manufacturer makes that choice, not the EPA or NSF.

The process of evaluating the existing data is as follows:

- Manufacturer or their designated FTO prepares a stand alone report in the EPA/NSF specified format presenting existing data for their equipment.
- The report is evaluated by qualified peer reviewers under NSF oversight.
- The performance data and QA/QC documentation are assessed against EPA/NSF criteria.
- Report revisions are made by the manufacturer/FTO as necessary.

The value of existing data reports is as follows:

- They indicate to states that acceptable EPA/NSF ETV peer reviewed data exists for a piece of equipment.

- Peer reviewers are independent experts in the treatment area under NSF oversight and the data is evaluated against specific criteria.
- The report identifies gaps in the data which may suit verification testing.
- The report fills in the matrix of treatment possibilities in combination with verification testing.

Therefore, this ETV pilot will have two services:
1. A peer review "evaluation" of existing data on equipment capabilities (with less stringent monitoring sampling, and QA/QC requirements)
2. Verification testing study (requirements based on ETV protocols and test plans)

A manufacturer can opt to do one or the other or both, in which case the verification report will contain an executive summary which details the peer reviewed existing data, the actual verification testing data, and a description of how these two components constitute a complete verification report.

The next steps in the process for existing data are:
- Draft acceptance criteria for each Test Plan
- Draft procedures and terms and conditions for performing a peer review of existing data
- Review, revise and recommend concerning technical and procedural issues

B. Discussion

Jeff reiterated that the data presented in the existing data report must be representative of all data collected for that piece of equipment, not just the best operating results. Including less desirable operating results means that everyone can learn from the previous mistakes instead of repeating them. Also, the data must include, at a minimum, operation and maintenance (O&M) data, source water data, and finished water data. Jeff asked if this seemed like a good process to everyone, even though all the details are not completely worked out yet. The general consensus of the meeting attendees is that this seems like a good approach.

Gary Logsdon stated that although cost cutting is important to the manufacturers, there must be quality data in order to evaluate their equipment. A possibility of collecting this type of quality data is to have operating facilities begin collecting the required data now and in one year, the manufacturer will have one year's worth of "existing" data. This concept falls somewhere between intensive testing and existing data reports that may lack adequate QA/QC.

The manufacturers present agreed that peer-reviewed existing data report seems like a viable option. They stated that the QA/QC requirements need to be realistic for the operators of the equipment.

Bob Mann is concerned that there will be a jumble of information under this scenario. He suggested retaining one FTO for peer reviews so the reviews are consistent, predictable, and objective. He also stated that compliance data which has been collected is basically as good as verification data.

Jerry agreed that perhaps one group of individuals (such as the American Water Works Association (AWWA)) could perform these reviews. The formats will be similar so peer reviews should be consistent. He asked the state representatives what they think of this approach.

John Sadzewicz stated that Ohio uses pilot test data from other states currently, and that it is generally useful in conjunction with testing. He has never seen a manufacturer pull together all existing data. Rick Sakaji stated that compliance and historical data are important, and that if you have a facility treating water, it seems like a good idea, but QA/QC (especially calibration of instruments) is extremely important. Jerry suggested that they ask the operators how often they calibrate the equipment as part of their data collection procedure. If the operators do not calibrate their instruments, do not include the data in the report.

Jerry stated that the next step is to look at what information (not just data) is needed in the existing data reports for each technology for the report to be peer reviewed and yield a useful tool. Rick Sakaji asked whether the existing data report would have the EPA/NSF names. Jeff and Jerry answered "yes." There will be two separate lists of reports: peer reviewed existing data report and verification reports. Jeff explained that if a manufacturer wants to use existing data to complement verification testing, an existing data report will be submitted for the equipment, the report will be reviewed, and an executive summary in the verification report will explain how the existing data complements the verification testing.

Bob Mann thinks that the existing data report with peer review will leave states wondering if the manufacturers copped out of verification testing. Is the existing data report equivalent to verification? Better than? Poorer than? Rick Sakaji added that California will likely require site-specific testing in addition to an existing data report, but that each state may use the reports differently.

John Dyson agrees that existing data, if nothing else, can be used as a cost-effective means to fill in the matrix of treatment possibilities.

Jeff stated that the manufacturers are free to choose their own course. They may want an existing data package review and/or verification testing, but it is up to them. The existing data report will not be verification, but it will be a stand alone report.

Joe Jacangelo stated that the existing data report will be a tool. The states will have to make their own judgment on it. He suggested that the manufacturers submit the existing data report before applying for testing to ensure that the peer reviewer agrees with their assessment of their testing needs.

John Sadzewicz stated that the FTO could collect more data during verification to validate the existing data and then have a verification report.

C. Next Steps or Action Items

The Steering Committee discussed the next steps for this idea on existing data:
(1) Acceptance criteria for existing data will be compiled for each test plan (see example in Attachment D) and the task force will provide their recommendations on the criteria. NSF will then have acceptance criteria outlined for each technology, so NSF will perform an initial screening on existing data reports, and then a peer reviewer with expertise in the technology area can review the existing data reports.
(2) NSF is to facilitate completion of acceptance criteria for each test plan as well as task force review of the criteria.
(3) NSF is also to develop a draft existing data report format (after a survey of states), a process for reviewing existing data, and policies and terms and conditions.
(4) The acceptance criteria, after being reviewed by the task force, will be reviewed by the appropriate protocol panel and then the Steering Committee.

IV. Steering Committee Membership Rotation (by Bruce Bartley, NSF International)

Bruce Bartley stated that he has received requests for adding new members to the Steering Committee and that he would like the Steering Committee to recommend a policy on how members will eventually rotate and be added as the project evolves into different phases. For example, the verification reports and statements will most likely be used by equipment manufacturers in sales to countries other than the U.S.A. How will other countries become involved in the project? What if tragedy befalls a present member? He reminded members that the EPA and NSF want a good cross section to ensure adequate representation.

Donna Cirolia suggested keeping consistency at least until the testing phase begins. Then perhaps something like three year staggered terms can be set up.

Bruce stated that he has received inquiries from universities, especially protocol and test plan writers and reviewers. Jeff Adams stated that these organizations act in a similar capacity as the consulting firms. Donna suggested that if a university becomes a qualified FTO, perhaps they would then be a good addition or replacement. We could add one representative from a University and one from Canada. Expanding the Steering Committee by two people will not likely change the dynamics.

Jeff Adams reminded meeting attendees that unless there is an actual vote, this process and project activities are open for comments from anyone who is interested.

Steve Clark thinks this is a good idea and that there may be better participation if different people are eligible for travel reimbursement.

John Sadzewicz asked how we would choose someone from Canada. Ross Holden said that there is a drinking water subcommittee of Health Canada that sets maximum contaminant levels (MCLs) for drinking water and has representatives from each province.

Gretchen Rupp added that there should be a distinction between universities and consulting firms, even though they may play the same role in the ETV pilot project. Universities are more research focused, and travel money to meetings such as this is hard to obtain. Also, as a group, universities are not well organized amongst themselves. Most get their information through AWWA. She thinks that the ETV can benefit from the Universities' point of view, so making a University representative a Steering Committee member may be a good idea.

May 20, 1997:

V. Level of Operation and Maintenance of Package Plant (by Dallas Post, AWWA)

A. Presentation

Dallas Post summarized the activities and results of the Task Force on Level of Operation and Maintenance/Ease of Operation. The Task Force discussed categorizing each piece of equipment as requiring an operator in one of three skill levels (basic, intermediate, and advanced, each of which were described in a handout at meeting-see Attachment E). There had been a discussion about adding two more skill levels, but decided that five skill levels may be too confusing. Dallas asked for comments.

B. Discussion

Jerry Biberstine noted that most states have four levels of certification for water treatment operators and wondered if it would make more sense to have four corresponding skill levels. Dallas responded that the lowest state certification is generally for groundwater chlorination only, and that can be included under the "basic" category.

Joe Harrison asked who will perform day to day functions on the small systems equipment. Many small communities have people who have no expertise in water treatment and also perform several other functions in the community. Bob Mann stated that there is a large difference between process complexity and process operation: For example, microfiltration. While it may be fairly easy to operate a microfiltration system, if something goes wrong with the system, it may be difficult to diagnose and repair.

John Sadzewicz stated that in general, Ohio is fairly conservative regarding operator skill level because they want someone who will know what to do when the system breaks down. Rick Sakaji stated that, in general, systems with more skilled operators tend to be run better than systems with operators having less skill.

Bob Mann suggested that not just operator skill should be included in the "ease of operation" category, but also ease of repair of the equipment. Dallas agreed and stated that this issue goes back to the importance of small systems operators. Good operators tend to keep critical components of the equipment on-site in case of an emergency, and if they don't have replacement equipment, they know where and how to obtain it within 24 hours.

Bruce Bartley stated that the Steering Committee can help augment the language in protocols as needed, but that the language should be changed as soon as possible, as other protocols are being started.

Jeff Adams suggested that protocols include a section on ease of operation. Joe Jacangelo stated that the protocols currently contain specifications during preparation of the Field Operations Document (FOD) of licensing requirements, monitoring ability from remote locations, ability for part time operation, etc. But more specific O&M requirements can be added. Brenda Land added that existing systems will be able to supply this type of data, but it will be difficult to obtain from four weeks of verification testing by an engineering firm.

Also, it had been suggested that the manufacturer submit the O&M manual with the FOD for review during verification testing. Jeff Adams stated that this idea will be looked into further.

Gary Logsdon stated that we need the flexibility to look at existing systems and a system to evaluate new equipment.

Joe Harrison stated it will be difficult to find operators capable of operating advanced equipment that are not already certified. The best system for a community may not be able to be operated by the community's operator. Allen Hammer suggested that maybe it's time that the states start to require a higher level of operators, as necessary, and take control of the small systems operators situation.

Jerry Biberstine stated that the updated protocol language, created based on the Task Force discussions, should be reviewed by Steering Committee members and commented on within the next two weeks. NSF will then finalize the draft document and submit ballots to incorporate the language into each protocol.

Donna Cirolia asked if the O&M manual will need to be submitted for a review or just submitted as an appendix to the FOD. Jeff Adams answered that the FTO will assess whether the O&M manual is sufficient and appropriate during verification testing. Then the manufacturer will be able to get some feedback and guidance on the O&M manual. Also, the FTO can assess whether the operator skill level specified is appropriate.

John Dyson stated that, in general, operators do not read the 50 to 60 page manuals they receive and suggested a two to three page outline for easier use. Rodney Herrington also stated that videos usually work well with operators.

C. Next Steps or Action Items

Bob Mann stated that what will be useful to the states is for the FTOs to explain how the manufacturers address the issues of operability, repair, etc. Jerry suggested having Joe Jacangelo and Gary Logsdon complete a checklist to be included in each protocol as operability parameters to be addressed during verification testing. Other FTOs can then make suggestions regarding this

list.

Jerry asked how we capture information regarding operability from existing systems. We would like to obtain information regarding problems, O&M, ease of repair, etc. to place in the executive summary, if existing data from these systems is submitted before verification testing. Donna Cirolia asked if we could obtain this information through a survey, because if the manufacturers put this information together, it may seem more like a testimonial than a report.

It is suggested that NSF or the FTOs contact the site where the equipment is in place using the list of sites provided by the manufacturer. The name and phone number of each of the sites could be included in the report so the states can contact these operators if desired.

Rick Sakaji stated that there may be a concern regarding operator pride. Operators may not want to discuss problems they have had with the system, so we should consider making this process as comfortable for them as possible.

Bob Mann suggested that someone may need to visit the sites to discuss these issues with the operators, as it may be difficult to obtain adequate information by telephone or through written communication.

Bridget O'Grady suggested using circuit riders to conduct the survey. The National Rural Water Association (NRWA) has circuit riders that travel from one drinking water treatment system to another to provide hands-on technical assistance. These circuit riders may be able to get more honest, balanced, realistic information since the operator may already know them and feel comfortable disclosing information to them. However, these circuit riders may not cover all areas where the verification testing may be done. States may be able to provide EPA/NSF with contacts for circuit riders.

John Sadzewicz asked what type of information will be collected during these surveys: preventative maintenance, ability to get replacement parts and change parts, ease of general operation, etc?

Jerry stated that for existing technologies, the technical project support can compose a list of questions for the survey for that technology and the Steering Committee can vote on its sufficiency.

VI. Validation Study Conducted by CH2M Hill in Tampa, Florida (by Jim Lozier, CH2M Hill)

A. Presentation

Jim Lozier summarized the process by which CH2M Hill conducted verification testing on a piece of equipment supplied by a manufacturer to the Tampa, Florida water treatment facility. CH2M Hill prepared the FOD and conducted testing based on the January 17, 1997 version of the Microbiological and Particulate Removal Protocol, and there have been some changes to this

protocol since they first received it.

Overall, Jim stated that the Protocol and Test Plan for Membrane Filtration were very well composed and covered the necessary items from his perspective. Although he has done a lot of pilot studies, Jim tried to compose the FOD from the perspective of a less experienced Testing Organization and was able to compile some suggestions to make the Protocol and Test Plan perhaps easier to use and more effective.

The validation study was performed with a microfiltration technology that is a membrane immersed in a tank. Only one week's worth of testing was performed, not a full month, as specified in the Test Plan. The source water is river in Tampa. There was a one day field audit performed by NSF.

This specific validation test had several limitations:

- There was no membrane pore size characterization performed.
- Only mandatory water quality parameters were tested.
- Grab sampling only was performed for turbidity (in-line particle counter did not operate properly).
- No cleanings were performed during the one week test period.

Significant events of the verification testing included:

- The manufacturer-supplied FOD was inadequate. The FTO must play a key role in the composition of this document.
- The test schedule was delayed two months from the original baseline due to all the parties involved (utility, manufacturer, FTO, NSF, etc.)
- The membrane integrity test plan, as discussed in the Test Plan, was not used.
- The operating conditions were modified in the field by the FTO in response to fouling. The manufacturer needs to run the system long enough to understand the operating parameters before turning the equipment over for verification testing.

Start-up issues of the validation study included the following:

- A process is needed to "de-bubble" the filtrate stream.
- The on-line particle counter was not operational and the technical support provided by the counter manufacturer was not adequate to diagnose the problem.
- The FTO had difficulty in obtaining "particle-free" water for calibrations.
- The filtrate particle counts require an extended period to obtain stability (it took 12 hours to get the particle counts down to where they were stable).

Based on the study, Jim Lozier summarized issues with the FOD, including the following:

- The first draft from the manufacturer was not adequate. This FOD had a dual purpose to meet NSF's testing objectives and also a study to be performed by the university of Central Florida after the ETV testing was complete. The FOD also reflected a lack of knowledge of the ETV pilot by the manufacturer.

- Major revisions were required by the FTO to:
  - follow the NSF format.
  - develop appropriate QA/QC procedures.
  - eliminate marketing aspects under the technical description prepared by the manufacturer.

Rick Sakaji asked the major reasons for the time delay. Jim Lozier responded that the lines of communication among all the parties (including the University of Central Florida, who was conducting a test after CH2M Hill) had not been established. Each party was new to the process and the utility was not under contract with any of the other parties. Jim suggested that in the future establishing a testing start date and then work back from there to get everything arranged in time.

Other issues with the FOD included:

- Preparation could be streamlined by tabulating requirements for FOD (note: NSF has already completed such a table).
- Give the FTO the primary responsibility for preparation, as they are better attuned to work planning and QA/QC requirements and can provide more consistency in document preparation (note: the Steering Committee has already agreed to proceed in this direction).
- QA/QC should be more specific to equipment calibrations.
- The FTO had limited information on the test site characteristics and feedwater characteristics.
- Responsibilities and schedule for equipment installation were not adequately determined.
- Involvement of utility may be critical to develop the type of information listed above.

Based on the study, Jim Lozier summarized issues with the Protocol, including:

- The requirements for the FOD were dispersed throughout the protocol: would be easier to use if they were tabulated (note: NSF has already completed such a table).
- Responsibilities and lines of communication are not clearly defined. Perhaps an organizational chart or flow chart would help.
- Responsibilities of NSF should be more clearly defined (relative to those of the manufacturer) (Section 2).
- References should be provided to Partnership for Safe Water, drinking water rules, etc. (Section 4).
- Specifics of the programs and regulations that pertain to the protocol should be cited (Section 4).
- Contaminant Removal Studies - justification for non-particulate data monitoring needed (Section 4).
- Discussion of the schedule should mention coordination efforts with the utility and their subcontractors and an allowance for that impact on the schedule (Section 4).
- The sentence in Section 5 that states “the FTO to supervise testing and sampling” implies that they will not be conducting the testing.
- Flexibility should be provided to allow utility or FTO to conduct testing to accommodate

the utility's capabilities (Section 5).

- Guidance should be provided in the Performance Evaluation Sampling section (Section 6) on where to obtain samples and what metric is used to determine if the results are acceptable.
- Section 6 should provide more guidance on the status reports to be issued by the FTO: frequency of issuance, format, content, etc.
- Section 6 should also provide more specifics regarding the audit reports, including who will perform the audits, and why they will be reported through the FTO rather than directly through NSF.
- Section 8 (Safety Measures) should provide procedural requirements for storage/handling/ disposal of hazardous chemicals (acids/bases/oxidizing agents) and requirements for a Safety Plan for the FTO.

Issues that Jim Lozier identified in the Test Plan during validation testing included:

- Section 6.7 should allow for a manufacturer-derived factor for temperature correction, if available.
- Preoperational testing for technologies treating "new" waters would prevent adjustments in operations due to rapid fouling during the month-long testing (Section 7.3).
- Testing conditions should be selected to achieve substantive fouling in the 30 day period (Section 7.3).
- The schedule for operational data collection is for minimal requirements: the manufacturer may specify more detailed information to be collected (Section 7.4.1).
- Specify when the data is to be collected (i.e., minimum spacing of six hours between sampling events) (Section 7.4.1).
- Specify parameters to be monitored for power and chemical consumption (amps and voltage, metering pump output and solution strength) (Section 7.4.1).
- In Section 7.4.2, what is the justification for measuring pH, alkalinity, and hardness relative to particle removal?
- In Section 8 (Cleaning Efficiency), flexibility should be provided to tailor chemicals and procedures to the nature of the foulant.
- Detailed procedures should cover pH neutralization and disposal of solutions (Section 8).
- Where applicable, sampling should include type of oxidant and concentration (Section 8).
- Cleaning regimen and flow, pressure and temperature should be documented (Section 8).
- The use of non-ratio turbidimeters may provide low results with highly colored samples (Section 9.3).
- Uniform formation conditions should reflect utility distribution system's conditions to make results relevant (Section 9.4.4).
- An additional method may be needed for immersed membrane technologies (Section 11).
- Include a direct "visual" method in Section 11.
- Specify the tank design that accommodates periodic visual access (Section 11).

Bruce Bartley stated that the main objective of this validation study was to evaluate the draft protocol and test plan and the proposed verification process. Results of the validation study were

the following:

- To write something on paper vs. doing it in real life is very different. Now we have experienced a validation study in practice, not just theory.
- There is not enough money to do a practice validation study for each Test Plan, so we will need to try to make the other Test Plans incorporate what we have learned from this study.
- During validation studies, FTOs should be able to write questions regarding the Protocols and Test Plans to NSF to clarify issues and NSF will forward these comments to the writer of the documents. Therefore the documents will be living documents which are molded based on real world experiences.
- A checklist has been developed to help in preparation of the FOD.
- More specifics need to be added to the Protocols regarding the calibration of different equipment.
- Based on the validation study for a microfiltration unit (which has the most required testing at four weeks, four times per year), the estimated effort for a FTO is 1,200 hours ±100 person hours. This time includes FOD preparation, data analysis, training, startup, pretesting, and reporting for Tasks 1 through seven in the Test Plan. The actual cost will depend on the personnel used and their hourly rate.

B. Discussion

There was then a discussion regarding the number of hours per day of testing. Will there be eight hours for each day of testing or could there be less? The consensus is that if the FTO must send a representative to travel to the site, the manufacturer will incur the costs for travel, per diem, and at least eight hours per day. However, if the test site is located near an office of a FTO, not only will the manufacturer save on travel costs, but the operator may be able to work part time in the office and charge less than eight hours per day to the validation test.

Jim Lozier estimated that the total laboratory costs for a microbiological removal verification test for an entire year will be approximately $6,000. Therefore, labor requirements are really going to drive the cost of the testing.

Donna Cirolia asked how labor hours will translate into dollar figures. Bruce Bartley stated that the actual cost will depend on the level of person does the testing and whether they are from a university or engineering firm. Greg McKelvey stated there may be a wide range of charges when validation testing begins, but eventually the market will level out from competition.

There was then a discussion regarding possibly using an on-site operator or utility employee to do the validation testing. Joe Jacangelo stated that the testing is too short term with too much at stake to use a utility employee. Jim Lozier stated that someone needs to be on-site that can interpret data “on the fly” to adjust to the field conditions.

Bruce Bartley stated that NSF and EPA are aware of the concerns regarding the cost of validation testing. They have requested additional funds from the EPA to subsidize the cost of testing. NSF

will advertise to try to get an idea of how many manufacturers are interested in participating and then will divide any monies received for validation testing. Jeff Adams stated that, at this time, we are hoping for $1.5 million. The paperwork is not complete, however, and we need a better handle on the interest level of manufacturers. Jeff said that, if approved, the money will be available from the beginning of testing.

VII. Protocol Development Status (by Bruce Bartley, NSF International)

Bruce showed a chart that has the status of each protocol and test plan (this chart can be found on the NSF verification home page under "Protocol Development Status"). In general, protocols and test plans are coming along very well, but we are working around the schedules of universities due to this busy time of year for them.

Microbiological Reduction is the highest priority. Some comments from final reviewers need resolution and after the protocol is redrafted, the Steering Committee will ballot on that document.

Microbiological Inactivation is a high priority. The Ultraviolet Test Plan is undergoing panel review and then states will have a chance to review and comment on it. The first draft of the On-site Halogenation Test Plan is currently under development. NSF is having difficulty finding someone to write the Oxidation Test Plan, but it will hopefully be started soon. The subcontractor NSF had retained to write the Electropotential Test Plan recommended not to proceed until more research and development are completed.

Disinfection By-Product Precursor is also a high priority. The draft Membrane Test Plan is available for review on the Internet and the GAC Test Plan has been started.

Nitrate is a high priority. The draft protocol has been completed and is on the Internet and the Ion Exchange and Reverse Osmosis Test Plans have been started.

Arsenic is a medium priority. The draft Protocol and Coagulation Test Plan are available for review. The Reverse Osmosis Test Plan for inorganic constituents will be referenced by the Arsenic Protocol. This Test Plan has been started.

Inorganics Protocol and Test Plan for Reverse Osmosis are medium priorities. NSF expects that this will cover fluoride, arsenic, sulfate, and desalinization.

The Synthetic Organic Chemicals (SOC) Protocol is a lower priority, but it has been started. The Volatile Organic Chemicals (VOC) Protocol is a lower priority and it will likely be started in June.

Radioactive Chemical Contaminants are also a low priority and NSF still needs to identify writers and reviewers for the protocol and test plans.

Bruce Bartley suggests, in order to save time and money, that the process for protocol and test

plan review be altered. Currently the documents undergo a technical review, are revised as necessary, are reviewed by a protocol panel, are revised as necessary, are reviewed by the states, are revised, and then go to the Steering Committee for ballot. Bruce proposes to have each document go to an open 45 day review period for all parties after the technical review. During the open review period, the document will be sent to each state and a letter will be sent to all other stakeholders notifying them of the review period.

Motion #2: Joe Harrison motioned to make the changes outlined as the new policy. Donna Cirolia seconded the motion. The Steering Committee unanimously approved this new system.

VIII. Priorities for Development of New Protocols (by Jerry Biberstine, Chairman)
Bruce Bartley stated he received three responses to his survey for the rating of importance of the protocols. Therefore, NSF will proceed using the recommendations of these three responses (as indicated above) unless anyone conveys strong disagreement.

Bruce stated that several manufacturers have contacted Bruce regarding their technologies and the technologies do not seem to fit under any of the current test plans. Therefore, two manufacturers are at the meeting to present their technologies to the Steering Committee and one other technology will be discussed for the Steering Committee to consider how to proceed with these technologies.

Joe Cohen of Performance Pool Products explained their technology for water treatment. This is a new filtration technique that they hope to be in production within two years. Their technology packs media similar to that of a sand filtration system into a hollow sphere. This utilizes less media and allows for greater flow. The media is mechanically compacted and acts like a solid. Backwashing the system is faster than a conventional system. He wondered if the ETV may need a special protocol or test plan for microfiltration without a coagulant. The system he presented does not use chemicals.

Jerry Biberstine stated that the question which arises is whether the technology could fit under an existing protocol or if a new protocol is required to address this technology.

Bob Mann questions the commercial readiness of the product. Jerry stated that we need to be looking into the future to be prepared when these newer technologies are introduced to the marketplace.

Greg McKelvey stated Kinetico is also involved with a pressurized filtration packaged technology with an engineered media. This technology is focused on smaller, non-filtered surface water systems. He said that he would be comfortable with a test plan based on the coagulation/filtration test plan for direct filtration without a coagulant (with no chemical feed).

Bruce Bartley asked the Steering Committee if a new test plan should be written. Donna Cirolia asked if the existing test plan could be altered to include these technologies. Gary Logsdon stated

a separate test plan would likely be easier for the user, but it would not take too much effort to redo the test plan for these technologies.

Motion #3: Donna Cirolia motioned to proceed with writing of the new test plan and the exact name can be determined later. Dallas Post seconded the motion and the Steering Committee unanimously approved.

Jim Bell of Smith and Loveless presented a technology which may not fit under any of the existing test plans. It is a fibrous element that is compacted when in filtration mode to exhibit single digit micron removal, but is capable of backwashing by rotation and stretching of the fibers. There is a vacuum steam pasteurization step prior to backwashing to kill cryptosporidium and giardia so they do not get back into the system. A test system is being run by a consulting firm, but when he approached the state about doing verification testing, they seemed to not have an interest in the ETV testing. He would like a recommendation on how to proceed.

Jerry Biberstine discussed the possibility of forming a technical subcommittee to the Steering Committee to make these type of decisions (whether to have a new protocol/test plan written for a technology).

Gary Logsdon suggested for the Smith and Loveless technology, a section could be added to the Bag and Cartridge Filter Test Plan for cleaning of the element rather than disposing. He also suggested that another test plan could be written for filtration without coagulation.

Bruce Bartley asked when manufacturers approach the project with a new technology, how should NSF proceed? Bring them to the Steering Committee? Form a subcommittee to deal with these questions?

Gary Logsdon thinks that the technical subcommittee idea is a good one and suggested that perhaps state representatives and their engineers could handle technical types of questions. Joe Jacangelo agreed, because the state representatives likely have the widest experience base for evaluating technologies because of their exposure to them.

Jeff Adams suggested that NSF prescreen any inquiries and then send them to this Technical Subcommittee.

Motion #4: Dallas Post motioned to have the state representatives serve on a Technical Subcommittee to advise the Steering Committee on protocol questions. Bob Mann seconded the motion. The motion carried unanimously.

Bruce Bartley mentioned the subject of companies with technologies using electromagnetic removal of constituents. For products aimed at scale removal, these products do not really fall under the scope of the ETV program because they do not address health effects. For those technologies claiming to remove microorganisms, NSF needs to know how the Steering

Committee would like to handle these inquiries.

Allen Hammer stated that there needs to be research and design work done to prove commercial readiness to the Steering Committee. Joe Jacangelo stated the technology in general needs a scientific explanation and peer review. Gary Logsdon agreed and said that we need enough information about how the process actually works and the scientific principals in order to write a protocol for the technology. John Dyson asked if there is anyone who knows enough about the technology to write a test plan and there does not seem to be anyone.

Jerry stated that our response to these requests, at this time, will be that we need reproducible, scientific evidence so that we can understand the principal of operation enough to write a test plan to challenge the technology.

Motion #5: John Sadzewicz motioned this response be a standard response for this time. Allen Hammer seconded the motion. The motion carried unanimously in favor.

Bruce Bartley reviewed the main topics of discussion and action items, which were the following:

- Qualify FTOs (FTOs)
  -Develop fees/Revise Terms and Conditions
  -Standard Operating Procedures for Qualifying FTOs
  -Announce Application Acceptance
- State Survey
  -Moderate Follow-up of current survey
  -Poll States for Data Report Format and O&M requirements
  -Straw man for State Review
  -Second Survey: -per each Test Plan
  -checklist
  -ASDWA to provide contact names and phone numbers
- Existing Data
  -Acceptance Criteria for each Test Plan
  -Format per States for Existing Data Report
  -Process (Flow Chart) for peer reviews
  -Terms and Conditions edits
- Generic Protocol Revisions
  -Ease of Operations checklist for the O&M Manual review
  -Consistency of Test Plans
- Microbiological & Particulate Protocol
  -Changes per Validation Study
  -Editorial Changes (policies and procedures)
  -Develop Test Plan for Uncoagulated Filtration
  -Modify Bag & Cartridge to include backwashing option
- Announce Intent to Test
  -to Commerce Business Daily

-Mail to manufacturers on NSF mailing list

Bruce asked about the next meeting. Bob Mann stated that he feels the conference calls are effective and maybe NSF should just plan to schedule another meeting after some more items are completed. Jeff Adams agreed that we can use conference calling and mailing for now and maybe meet again in September. Bruce agreed and mentioned the middle or end of September.

Jerry Biberstine adjourned the meeting at 2:25 p.m.

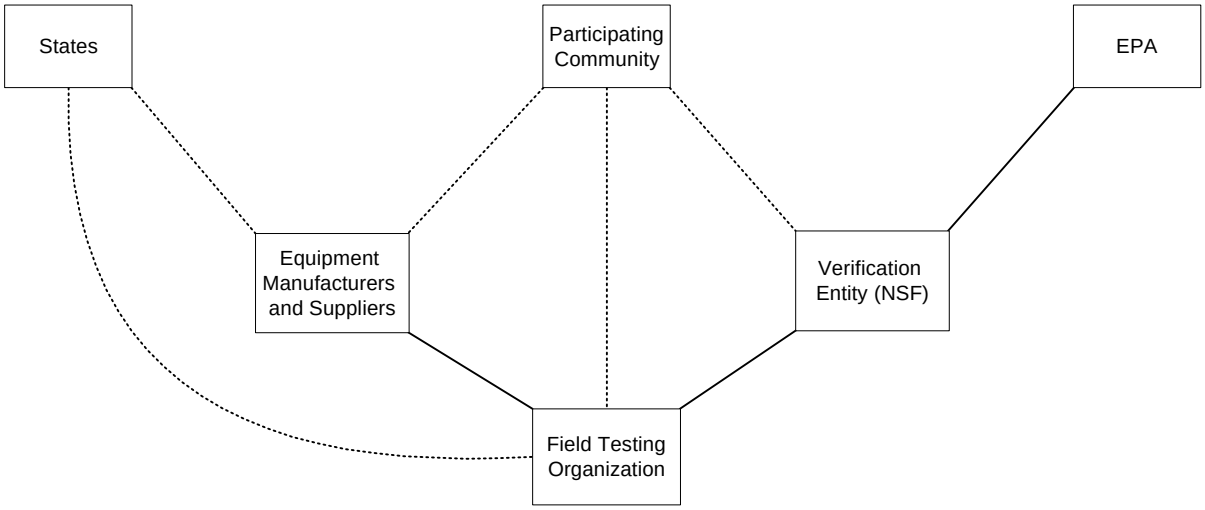
Meeting Attendees:
Jerry Biberstine, ASDWA/Colorado* [x]
Gary Logsdon, Black & Veatch* [x]
Greg McKelvey, Kinetico Inc.* [x]
Joe Jacangelo, Montgomery Watson* [x]
Steve Clark, U.S. Environmental Protection Agency - Washington D.C.* [x]
Donna Cirolia, Culligan International* [x]
Dallas Post, AWWA* [x]
Allen Hammer, Virginia Department of Health* [x]
John Sadzewicz, Ohio Environmental Protection Agency* [x]
Joe Harrison, WQA* [x]
Jeff Adams, U.S. Environmental Protection Agency*
Bruce Bartley, NSF International *
Bob Clark, U.S. Environmental Protection Agency - Cincinnati*
Ben Lykins, U.S. Environmental Protection Agency - Cincinnati*
Richard Sakaji, California Department of Health Services
Terry Gross, North Carolina Department of Environmental Health and Natural Resources
James Monroe, North Carolina Department of Environmental Health and Natural Resources
Robert Mann, New Hampshire Department of Environmental Services
Carol Becker, NSF International
Harry Grenawitzke, NSF International
Bruce DeMaine, NSF International
Kim Fox, U.S. Environmental Protection Agency - Cincinnati
Jim Goodrich, U.S. Environmental Protection Agency - Cincinnati
Tom Sorg, U.S. Environmental Protection Agency - Cincinnati
Bridget O'Grady, ASDWA/Washington D.C.
Allison Wayman, ICF Kaiser
Ross Holden, Health Canada
Jim Lozier, CH2M Hill
Rick Farmer, Calgon Carbon
Brenda Land, U.S. Forest Service
Anne Braghetta, Montgomery Watson
John Dyson, Infilco Degrement
David Pearson, PCI Membrane Systems
John Hoff, Sherwell Sci. Inc.
Jim Bell, Smith & Loveless, Inc.
Gretchen Rupp, Montana Water Center
Rodney Herrington, MIOX
Joe Cohen, Filtrasonics
Bill Schlanger, Filtrasonics
Sandy Games, Spectrum Labs

* Denotes Steering Committee members (voting and ex-officio)
[x] Denotes only voting Steering Committee members

ATTACHMENT A

RELATIONSHIPS BETWEEN STAKEHOLDERS

Relationships Between Stakeholders Involved in the Environmental Technology Verification Program for Packaged Drinking Water Treatment Systems.



ATTACHMENT B

DRAFT QUALIFYING TESTING ORGANIZATIONS FOR THE ETV PROGRAM

DRAFT QUALIFYING TESTING ORGANIZATIONS FOR THE ETV PROGRAM

The Manufacturer will select a field testing organization, a chemistry laboratory, and a microbiology laboratory from the pool of EPA/NSF-qualified organizations and the field testing organization will submit the chosen organization(s) as part of the initial application (see EPA/NSF policies for more information on the application process). One organization may fulfill the requirements for these three entities, or three separate organizations may be specified. In order for the organizations to be approved by NSF, they must meet the following minimum requirements, with secondary qualifications preferred.

Field testing organizations may include engineering consulting firms, universities, or other qualified scientific organizations. The required and preferred qualifications are stated below.

Required Qualifications for a Field Testing Organization:

1. Professional Engineer with experience in conducting a minimum of three drinking water pilot studies will oversee field testing operations.
2. Organization has experience in conducting drinking water pilot studies for an individual state or for an organization conforming to the requirements of the state. The study must have been satisfactorily performed, as indicated by the governing state agency. Examples of the study's or project's report(s) shall be submitted to demonstrate the organization's capability to prepare acceptable documentation of conducted studies.
3. Organization has experience in preparing and executing a project-specific quality assurance/quality control plan (i.e Quality Assurance Project Plan) for a package drinking water treatment project or pilot study under the direction of the EPA, AWWARF, EPRI, National Water Research Institute or other relevant organization.
4. If requirements 2 and 3 are not met, the organization has demonstrated equivalent experience to requirements 2 and 3.

Secondary Qualifications for a Field Testing Organization:

1. Professional Engineer at Organization has relevant drinking water articles published in peer-reviewed journals such as *Journal AWWA* , *Environmental Science and Technology* , *ASCE Journal of Environmental Engineering* , *Water Research* , etc.
2. Organization is registered to ISO 9001, ANSI/ASQC E4-1994 or other pertinent quality management system standards.
3. Organization has participated in a Good Laboratory Practices water or drinking water treatment study.

For **chemistry and microbiology laboratories** , minimum and preferred qualifications are as follows:

Required Qualifications for a chemistry or microbiology laboratory:

1. Laboratory must be certified for analysis of water samples for Safe Drinking Water Act compliance by one or more states having Safe Drinking Water Act primacy.

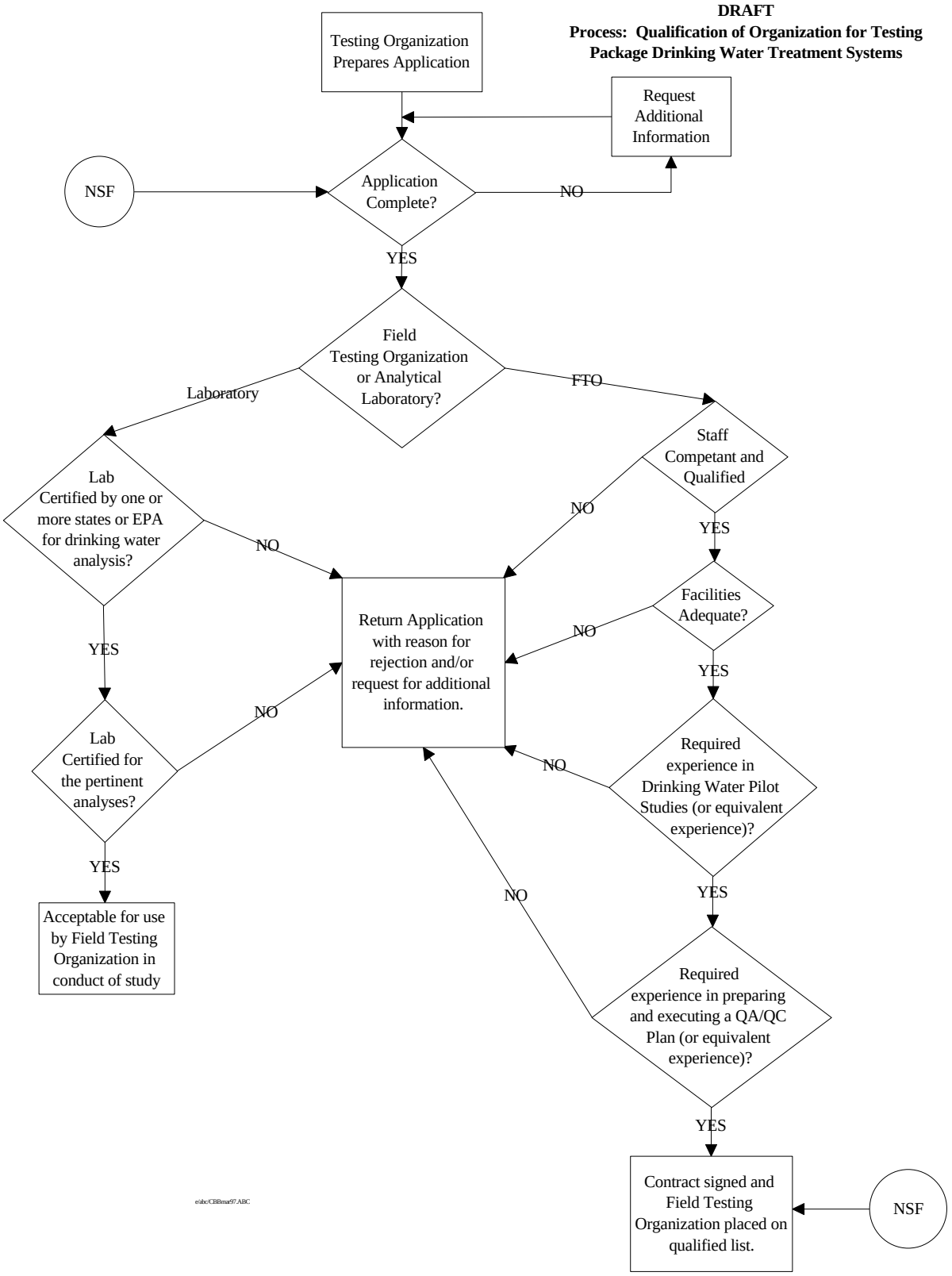
2. Laboratory must be certified by a state for the pertinent analysis.
3. Principal Investigator or Technical Manager has professional experience in conducting drinking water analyses for state compliance monitoring.

Secondary Qualifications for a chemistry or microbiology laboratory:

1. Laboratory is accredited by a third party organization (e.g. NSF) for the work to be subcontracted based on ISO/IEC Guide 25 or EN 45001.

ATTACHMENT C

DRAFT PROCESS: QUALIFYING OF ORGANIZATIONS FOR TESTING PACKAGE DRINKING WATER TREATMENT SYSTEMS


DRAFT
Process: Qualification of Organization for Testing Package Drinking Water Treatment Systems
Testing Organization Prepares Application
Request Additional Information
NSF
Application Complete?
NO
YES
Field Testing Organization or Analytical Laboratory?
Laboratory
FTO
Lab Certified by one or more states or EPA for drinking water analysis?
Staff Competant and Qualified
NO
YES
NO
Facilities Adequate?
Return Application with reason for rejection and/or request for additional information.
NO
YES
YES
NO
Lab Certified for the pertinent analyses?
Required experience in Drinking Water Pilot Studies (or equivalent experience)?
NO
YES
YES
NO
Acceptable for use by Field Testing Organization in conduct of study
Required experience in preparing and executing a QA/QC Plan (or equivalent experience)?
YES
Contract signed and Field Testing Organization placed on qualified list.
NSF
e\abc\CBBmar97.ABC

ATTACHMENT D

EXAMPLE CHECKLIST OF O&M REQUIREMENTS FOR THE TEST PLAN FOR MEMBRANE FILTRATION FOR THE REMOVAL OF MICROBIOLOGICAL AND PARTICULATES

The following is an example of checklist of required, suggested, and recommended testing parameters for the Test Plan for Membrane Filtration for the Removal of Microbiological and Particulate Contaminants. A "1" under suggested ranking indicates that this parameter is necessary for complete evaluation of historical performance and a "2" indicates that while the data would enhance interpretation, it is not critical for evaluation.

Test Plan requirements	**Suggested ranking of importance of requirements for existing data packages (1=necessary, 2=not critical)**	**Recommendation by Task Force**
Operability parameters (per recommendations of Task Force)	1	
Raw water flow	1, daily	
Influent module/vessel pressure	1, daily	
Effluent module/vessel pressure	1, daily	
Filtrate pressure	1, daily	
Filtrate flow	1, daily	
Stage 2 pressure, flows, and crossflow velocity, if applicable	1, daily	
Power costs	2	
Feed water characteristics: -Temperature -Turbidity -Total suspended solids (TSS) -pH -Alkalinity -Hardness -Total Coliform/heterotrophic plate count	 1, weekly 1, daily 2 1, weekly 2 2 1, biweekly	 _____ _____ _____ _____ _____ _____ _____
Cleaning frequency, if applicable	1	
Cleaning efficacy, if applicable	1	
Assessment of irreversible fouling potential and estimation of usable membrane life for costing purposes	1 (membrane life as reported by Manufacturer)	
Finished water characteristics: -Alkalinity -Hardness -Total dissolved solids (TDS) -TSS -Total organic carbon	 2 2 2 2 2 (unless NF or RO used, then 1)	 _____ _____ _____ _____ _____

Test Plan requirements	**Suggested ranking of importance of requirements for existing data packages (1=necessary, 2=not critical)**	**Recommendation by Task Force**
Finished water characteristics (continued): -$UV_{254\ nm}$ absorbance -Total coliform and heterotrophic plate count bacteria -Temperature -pH -Filtrate water turbidity -Filtrate water particle concentrations -Feed (and concentrate) water turbidity - Feed (and concentrate) particle concentrations	 2 (unless NF or RO used, then 1) 1, biweekly 1, weekly 2 1, daily 2 1, daily 2	 _____ _____ _____ _____ _____ _____ _____ _____
Maximum membrane pore size	1, as reported by Manufacturer	
Membrane integrity over time	2	
QA/QC Verification of chemical feed pump flowrates	1, monthly	
QA/QC Verification of in-line turbidimeter flowrates	1, monthly	
QA/QC Verification of batch and in-line particle counter flowrates	2	
QA/QC Verification of in-line and flowmeters/rotameters	1, monthly	
QA/QC Verification of in-line turbidimeters (clean out reservoirs and recalibrate)	1, monthly	
QA/QC Verification of differential pressure transmitters (verify gauge readings and electrical signal using a pressure meter)	1, monthly	
QA/QC Verification of tubing (verify good condition of all tubing and connections)	2	
QA/QC Verification of particle counters (perform microsphere calibration verification)	2	

Test Plan requirements	**Suggested ranking of importance of requirements for existing data packages (1=necessary, 2=not critical)**	**Recommendation by Task Force**
Optional: For Task 8, removal of Giardia and Cryptosporidium	1 (if verification for removal of Giardia and Crypto is desired)	
For Task 8, removal of virus	1 (if verification for removal of viruses is desired)	
For Task 9, raw water, pretreated feed water and filtrate water characteristics:		
-alkalinity	1, biweekly	_____
-hardness	1, biweekly	_____
-TDS	2	_____
-TSS	2	_____
-total organic carbon	1, biweekly	_____
-$UV_{254\ nm}$ absorbance	1, biweekly	_____
-total coliform and heterotrophic plate count bacteria	1, biweekly	_____
-temperature	1, weekly	_____
-pH	1, weekly	_____
-filtrate water turbidity	1, daily	_____
-filtrate water particle concentrations	2	_____
-raw water and pretreated feed water turbidity	1, daily	_____
-raw water and pretreated feed water particle concentrations	2	_____
For Task 9, flux recovery	1	
For Task 9, transmembrane pressure	1	
For Task 9, cleaning frequency	1, if applicable	

ATTACHMENT E

RECOMMENDATIONS FOR OPERATOR SKILL LEVELS

Recommendations For Operator Skill Levels

Basic Level Operator:

Operator understands and applies common disinfection methods in a safe and responsible manner. This individual can operate bag/cartridge filters, as well as slow sand filtration treatment according to written instructions. The basic level operator can collect, record and mail water quality samples as required by regulations.

Intermediate Level Operator:

Operator performs all tasks described under the basic level operator requirements and has some basic knowledge of such treatments as ion exchange, granulated activated carbon, diatomaceous earth and aeration, and more sophisticated disinfection procedures. Operator is motivated to attend training sessions and knows where to call when help is needed.

Advanced Level Operator:

Operator is comfortable with and able to perform all duties described in the two previous categories. Thoroughly familiar with regulatory demands as they apply to drinking water. This class of operator understands treatment chemicals, filter aids, and can calculate dosing requirements. Operator can interpret drawings and operation manuals. The advanced level operator is a resource to the water utility for purchasing, management and operational advice.

TABLE 1
PRELIMINARY GUIDANCE FOR PROCESS SELECTION

PROCESS	COST RANGE (relative)	CONTAMINANT	OPERATOR SKILL
Chlorination			
gas	low	Micro	intermediate
solution	low	Micro	basic
granules	low	Micro	basic
Ozonation	low	Micro	advanced
Ultraviolet radiation	high	Micro	intermediate
Aeration	medium	Organics/Rn, VOCs	intermediate
Ion exchange	medium	Ba, Na, Ra, As, Se, Inorganics, F^-	intermediate
Actived alumina	high	F, As, Se, Inorganics	advanced
Coagulation/filtration	medium	As, Se, Turb, micro	advanced
Membranes			
Microfiltration	medium	Turb, micro, some viruses	advanced
Ultrafiltration	medium	MF removal + most viruses, humic acids, organics	advanced
Nanofiltration	medium	MF + UF Removal + hardness	advanced
Reverse Osmosis	medium	F, N, Ba, Ra, As, Se, Turb, Mb, Inorganics	advanced
Electrodialysis and ED Reversal	medium	RO removal, no neutral or weakly charged ions	advanced
Adsorption	medium	Rn, Organics, VOCs	intermediate
Slow sand	low	Turb, micro	basic
Diatomaceous earth	low	Turb, micro	intermediate
Bag filters	low	Turb, micro	basic
Lime softening	medium	Organics, inorganics, micro	intermediate